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Research paper

The evolution of tree nursery offerings in Los Angeles County over the last 110 years

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HIGHLIGHTS

- We investigated nursery tree offerings from 1900 to 2010 in Los Angeles County.
- The diversity offerings increased significantly.
- Tree nursery offerings may provide insights about the diversity of urban trees.

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ABSTRACT

Interest in urban vegetation has increased dramatically. Urban trees are an important aspect of the urban environment but there is little known about the potential sources of those trees, change in tree species diversity over time and the factors leading to the contemporary floristic composition in cities. We investigate tree nursery offerings in Los Angeles County over the past 110 years through the use of here-to-fore unexplored nursery catalogs to determine the diversity of trees that have been commercially available over time. Tree species information was collected spanning a 110-year study period and analyzed the data for four time periods (1900–1929, 1930–1959, 1960–1989, and 1990–2011). We found the number of genera and tree species offered significantly increased in the past 20 years (1990–2011). The numbers of non-native trees, angiosperms, and deciduous species all significantly increased with but no changes were observed in the numbers of native, evergreen, or gymnosperm species offered over this time period. The largest numbers of palm species were offered in 1900–1929. Overall there were 562 unique species offered belonging to 201 different genera in the 120-year study period, 48 species were California native trees and 514 of these were non-native species indicating that perhaps Los Angeles has one of the most diverse number of tree species offered for sale by the nursery industry.

1. Introduction

Urban trees are garnering increasing attention in this era of interest in biodiversity and urban sustainability. There is growing recognition that urban areas are largely the result of human decisions and actions – they are constructed spaces. When cities are designed and built, for example, local vegetation is usually removed, and the earth recontoured and/or excavated to facilitate construction. Trees and other types of vegetation are then planted in this new built environment (Francis, Lorimer, & Raco, 2011; Pincetl, 2012). The species chosen can be culturally, historically, or functionally significant, but it is logical to think that species planted are generally representative of species available from the local nursery industry at the time and may or may not draw from the native flora of a regional ecosystem (for the purposes of this paper, the region is defined as Los Angeles County, 10,578 km^2). Regional nursery catalogs as a data source for urban biodiversity have not been evaluated prior to this research. Yet, the horticultural industry has been shown to be an important contributor to regional biodiversity with regard to invasive species distributions (Drew, Anderson, & Andow, 2010; Reichard & White, 2001). This paper contributes to the literature on urban biodiversity by suggesting that plants offered by nurseries are a source of yet-to-be-explored diversity in cities. We hope that this research will

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encourage the further consideration of the role of nurseries in urban biodiversity.

The significant historical legacy of tree introductions by European and Eastern U.S. settlers in California likely accounts for the initial urban tree diversity of Los Angeles and Southern California. The early 17th-century missionaries came with a culture of planting both crop-yielding and ornamental trees (Niemann, 2002; Padilla, 1961; Rowan, 1957; Willard, 1901) and this tree palate was substantially supplemented with the advent of the intercontinental railroad and increased oceanic traffic connecting Southern California with the world in the 19th Century. An innovative horticultural industry emerged in California which both catered to, and shaped the tastes of, settlers (Padilla, 1961; Taylor & Butterfield, 2003). Today Los Angeles has an exceptionally diverse tree assemblage where the imprint of this early period can still be detected. Referred to as the Garden of Eden, Paradise, and the Garden of the Hesperides throughout its relatively young history, images from this region spread worldwide (Chytry, 2006; Padilla, 1961; Willard, 1901).

There are a number of historical and social factors that can shape and influence tree species composition and diversity in cities beyond biophysical ones such as climate, environment, and ecological factors (de la Maza, Hernandez, Bown, Rodriguez, & Escobedo, 2002; Grove et al., 2006; Hope et al., 2003; Jim & Liu, 2001; Kendal, Williams, & Williams, 2012; Kinzig, Warren, Martin, Hope, & Katti, 2005; Kirkpatrick, Daniels, & Zagorski, 2007; Kunick, 1987; Lubbe, Siebert, & Cilliers, 2010; Martin, Warren, & Kinzig, 2004; Schmid, 1975; Talarchek, 1990; Welch, 1994). Cultural factors (Fraser & Kenney, 2000; Head & Atchison, 2004), and factors related to symbolic and representational associations of trees (Thayer & Atwood, 1978; Ulrich, 1986; Dwyer, Schroeder, & Gobster, 1991; Relf, 1992; Hansen-Moller & Oustrup, 2004) are also important. However, one possible critical factor in the planting and distribution of trees in the urban environment that has not been investigated previously, and is certainly related to the factors above, is the selection of tree species available from the nursery industry of the region. People obtain trees from purveyors, and thus this article examines the evolution of the selection of trees available from tree nurseries and seed availability. If there is no stock or seeds locally available, the burden of finding a desired tree is much higher. Thus we suggest that a window into which trees are found in the urban fabric may be by examining nursery catalogs over time.

This paper describes results from a longitudinal study of nursery offerings of tree species from 1900 to 2010. Los Angeles County has around 6 million trees in a bioregion that naturally supported trees only along riparian corridors and along the foothills of the city-region (Nowak, Hoehn, Crane, Weller, & Davila, 2011; McPherson, Simpson, Xiao, & Wu, 2011). As Schoenherr (1992) and Rundel and Gustafson (2005) have documented, in pre-colonial cismontane Southern California was dominated by chaparral and coastal sage scrub. Trees were mostly found in riparian corridors and along the foothills and included 14 native species. To understand the role of the landscape nursery industry in influencing diversity of the tree canopy cover, we developed three main areas of inquiry. First, we examined whether there has been a significant change in the number of tree genera and species offered by tree nurseries over time. Second, we asked whether there have been significant changes in the functional classifications of trees (natives, non-natives, evergreen, deciduous, angiosperms, gymnosperms, palms) offered over time. Finally, due to the size of the data set we were curious to know whether some species had been offered consistently from the early 1900s to 2011.

2. Methods

2.1. Study area

The focus of this research is Los Angeles County, established in 1850 as one of the counties in the State of California. Los Angeles County has a land area of 10,578 km^2 and has a population of about 10.4 million (County of Los Angeles Annual Report 2008–2009, 2010). The region is characterized by a Mediterranean climate with average annual precipitation of 394 mm and average daily high/low temperatures of 20.05 °C/9.2 °C in January and 29.3 °C/18.7 °C in August recorded at the downtown Civic Center (County of Los Angeles Annual Report 2008–2009, 2010). Los Angeles County includes 88 cities as well as 140 unincorporated areas (County of Los Angeles Annual Report 2008–2009, 2010). It was once the most fertile and productive agricultural region in the U.S. (Surls & Gerber, 2010).

2.2. Nursery catalog data collection

The limited historical documentation available from the California Department of Food and Agriculture was supplemented with archival catalogs. We located two nursery catalog collections in the region: (1) Collection of Nursery Catalogs (Collection 1207) in the Department of Special Collections located in the Charles E. Young Research Library, University of California, Los Angeles, and (2) the collection of catalogs available at the Los Angeles County Arboretum and Botanic Garden Library. (3) The 2009 and 2011 catalogs of West Covina Nurseries and Monrovia Nurseries, both large and well known nurseries in the region, were accessed on the company's websites respectively (Table 1). We exclusively utilized catalogs of nurseries located in Los Angeles County.

Data collection involved manually transcribing tree species information from each catalog into a database for further analysis. Species that were 12 feet (3.6 m) and taller were classified as trees in this analysis. Images of the catalog pages were scanned and converted to text using optical character recognition

Table 1
List of nurseries sampled in this article with year of publication, source, and city of location.

Number	Nursery	Year	Source	City
1	Johnson & Musser Seed Company	1906	UCLA	Los Angeles
2	Winsel Nurseries	1916	UCLA	Los Angeles
3	Paul J. Howard's Flowerland	1924	UCLA	Los Angeles
4	Mission Nurseries	1940	UCLA	San Gabriel
5	Vosburg's Garden Center	1950	Arboretum	Glendale
6	Burkard Nursery Inc.	1962	Arboretum	Pasadena
7	Olle Olson Nursery Inc.	1971	Arboretum	Monrovia
8	Mayflower Nurseries Inc.	1980	Arboretum	Gardena
9	Norman's Nursery	2005	Arboretum	San Gabriel
10	West Covina Nurseries	2009	Arboretum, website[b]	La Verne
11	Monrovia	1937, 1951, 1958, 1970, 1981, 1993, 2004, 2011	Arboretum, website[a]	Azusa

[a] http://monrovia.com/plant-catalog/.
[b] http://wcnurseries.com.

Table 2
Number of catalogs sampled in each time period from 1900–2011.

Time period	Number of catalogs
1900–1929	3
1930–1959	4
1960–1989	6
1990–2011	5

software. The location of the nursery, the year of the catalog, scientific name, and names of varieties (or sub-species) were recorded. Information was also collected for commercial fruit trees but is not included in this analysis. In order to classify the tree as deciduous or evergreen, native or non-native (to California), angiosperm or gymnosperm, we used the Sunset Western Garden Book (Brenzel, 2007). Gymnosperms were classified as tree species belonging to Araucariaceae, Cupressaceae, Ginkgoaceae, Pinaceae, Podocarpaceae, Sciadopitayaceae, and Taxaceae families (Christenhusz et al., 2011). Tree fern species (*Dicksonia antarctica*, *Dicksonia fibrosa* and *Alsophila australis*) were classified as ferns.

Catalogs were chosen to represent every decade from the 1900s to the 2010s. This 110-year period was split into four periods of 30 years each in order to conduct the statistical analysis, because the numbers of catalogs represented in each time period was different (Table 2).

A total of 18 unique nursery catalogs were sampled for this research. The number was restricted by availability in the archival collections. The number of catalogs sampled in each time period differed such that period one (1900–1929) had three catalogs, period two (1930–1959) had four catalogs, period three (1960–1989) had six catalogs, and period four (1990–2011) had five catalogs. We streamlined the study design by sampling at least one nursery catalog to represent each decade (1900–1909, 1910–1919, and so on). While it is likely that having more catalogs, and in turn, having a larger sample size, especially in the earlier decades, would have yielded more robust trends and results for the earlier decades, it is unlikely this would have changed the overall results.

2.3. Data analysis

The large data set was then analyzed using both Microsoft Excel 2011 and MATLAB 10. MATLAB was used to obtain specific numerical information (e.g. number of native species offered in each study period, etc.). Using a statistical count model we were able to predict the number of species (or genera) offered in each time period; we suspect that the difference in number of catalogs sampled would have little to no effect on the actual number of species offered, thus the overall result would still not change. The entries were optimized manually to account for spelling errors, alternative names, and repeats. In order to compare the time periods and the different numbers of catalogs sampled in each time period, we employed a negative binomial regression count model. This allowed for comparison between time periods by predicting the number of species (or genera) offered in each time period. One goal of the analysis was to identify whether there was a statistically significant difference in the number of species throughout the time period, and we found there was with a 95% confidence interval. A polynomial contrast was used to detect linear and quadratic trends with time. An exponential model was also used to analyze the same data. However, unlike the count model, the exponential model did not take into consideration the difference in the number of catalogs used in each time period. While the results indicated that both models fit the data, we chose to use the negative binomial regression count model because it took into consideration the differences in the number of catalogs used in each time period. We also found that there were fifteen species offered consistently in every decade.

2.4. Interviews

We used the nursery catalogs to identify wholesale and retail nurseries, and city websites to identify cities that had municipal arborists. We developed an interview protocol that was approved by the UCLA Institutional Review Board, and sent formal letters to a subset of each category. We followed up with e-mails and telephone calls to set up interviews to ascertain what factors have been driving tree choice in Los Angeles. We were able to obtain no interviews with retail nurseries after attempting to reach a dozen. None responded either to our e-mail inquiries, and those we reached by telephone to ask for an interview declined. We interviewed two sales people in person from wholesale nurseries, and two municipal arborists, one in Santa Monica and one in Beverly Hills. The interviews were based on an interview protocol that asked about drivers of supply (wholesale growers) and concerns driving demand for municipal arborists.

3. Results

3.1. Nursery catalog analysis

A total of 2840 tree entries were recorded for the 110-year study period. Out of the 2840 entries, a total of 562 unique tree species were identified belonging to 201 different genera (Fig. 1). Out of the 562 species, 514 were non-native and 48 were California native species (though not all native to Southern California); 365 were evergreen and 197 were deciduous species; 470 were angiosperms, 89 were gymnosperms and 3 were ferns. Emblematic of Los Angeles, 29 different palm species were offered. There were 194 species offered only once in the 110-year study period; of these, 70 species were offered within the last decade (2000–2011).

3.2. Species diversity

Using the negative binomial regression count model with 95% confidence intervals, the increase in the number of *species* offered in the most recent time period 1990–2011 was significant compared to time periods 1900–1929, 1930–1959, and 1960–1989. The 95% confidence interval of time period 1990–2011 did not overlap with the 95% confidence intervals of the other time periods (Fig. 2). There was no significant difference in the number of species offered between time periods 1900–1929, 1930–1959, and 1960–1989. A polynomial contrast indicated a significant linear ($p < 0.05$) and quadratic ($p < 0.05$) trend with time.

The number of *genera* offered in time period 1990–2011 was also significantly higher when compared to the number offered in time periods 1900–1929, 1930–1959, and 1960–1989. However, as with species of trees, no significant difference in the number of genera was observed between time periods 1900–1929, 1930–1959, and 1960–1989. The 95% confidence interval of the 1990–2011 time period did not overlap with the 95% confidence intervals of the other time periods (Fig. 2). A significant linear ($p < 0.05$) and quadratic ($p < 0.05$) trend was observed with time.

3.3. Species functional classifications

There was no significant change in the number of evergreen species offered in all of the four time periods and there was no linear or quadratic trend with time. In the case of deciduous species, the number of species offered in time period 1990–2011 was greater than the number of species offered in time periods 1900–1929, 1930–1959, and 1960–1989. There was no significant difference in the number of species offered in time periods 1900–1929, 1930–1959, and 1960–1989. A strong linear trend ($p < 0.001$) was observed with time (Fig. 3).

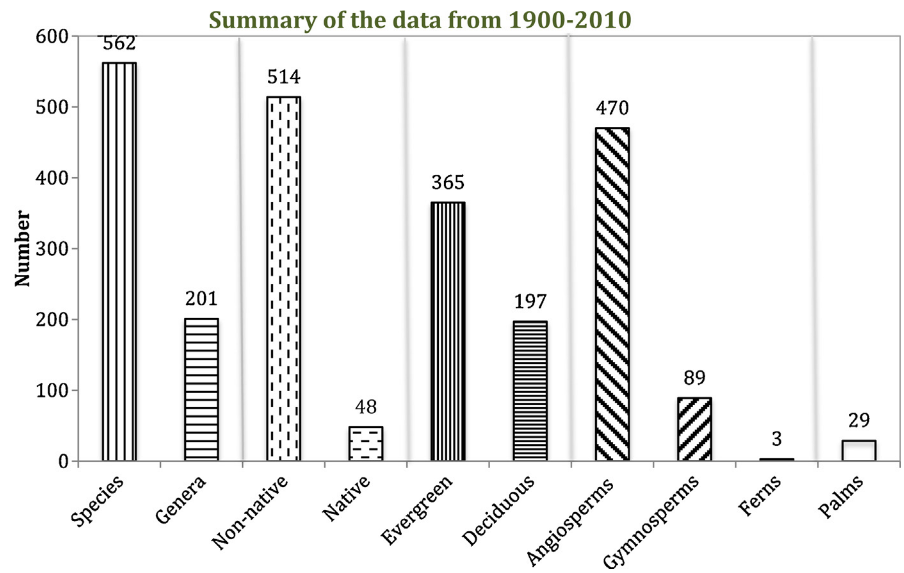

Fig. 1. Summary of nursery catalog analysis spanning the 120-year study period.

There was no observable change in the number of California native species offered over time (Fig. 3). While California boasts several dozen native trees, as mentioned above, there are only 14 native to *Southern* California, including such species as weedy willows that do not do well in an urban environment and cannot be used as street trees. Many of California's native trees do not thrive in Southern California's Mediterranean climate, like bristle cone pine, white fir, and pacific yew, among others. In the case of non-native species, the number of species offered in time period 1990–2011 was significantly greater than the number of species offered in time periods 1900–1929, 1930–1959, and 1960–1989. Similar to the pattern with deciduous species, the numbers of species offered between time periods 1900–1929, 1930–1959, and 1960–1989 were not significantly different. Both linear ($p < 0.05$) and quadratic ($p < 0.05$) trends were observed with time for non-native species (Fig. 3).

Gymnosperm species showed a unique trend. While the number of species offered in time period 1990–2011 was not significantly different from time periods 1900–1929 and 1960–1989, it was significantly different from time period 1930–1959. The results of the polynomial contrast indicated a quadratic trend ($p < 0.05$) with time (Fig. 4). Angiosperm species followed the same pattern as deciduous species and non-native species; the number of species offered in time period 1990–2011 was significantly greater than the number of species offered in time periods 1900–1929, 1930–1959, and 1960–1989. There was no significant

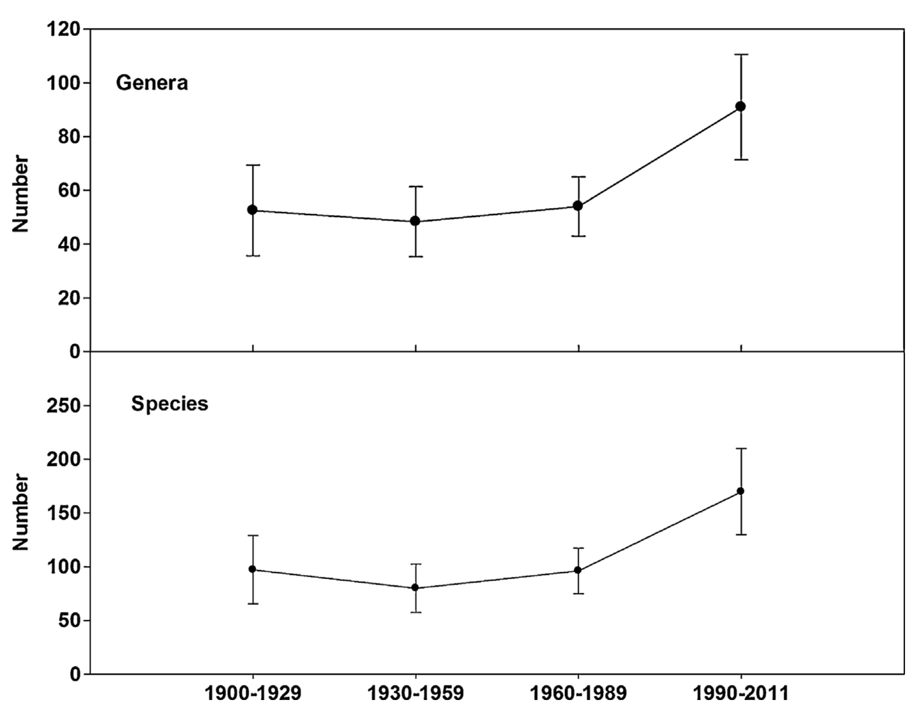

Fig. 2. Change in the number of species and genera offered by tree nurseries in LA County from 1900 to 2011 demonstrated using 95% confidence intervals.

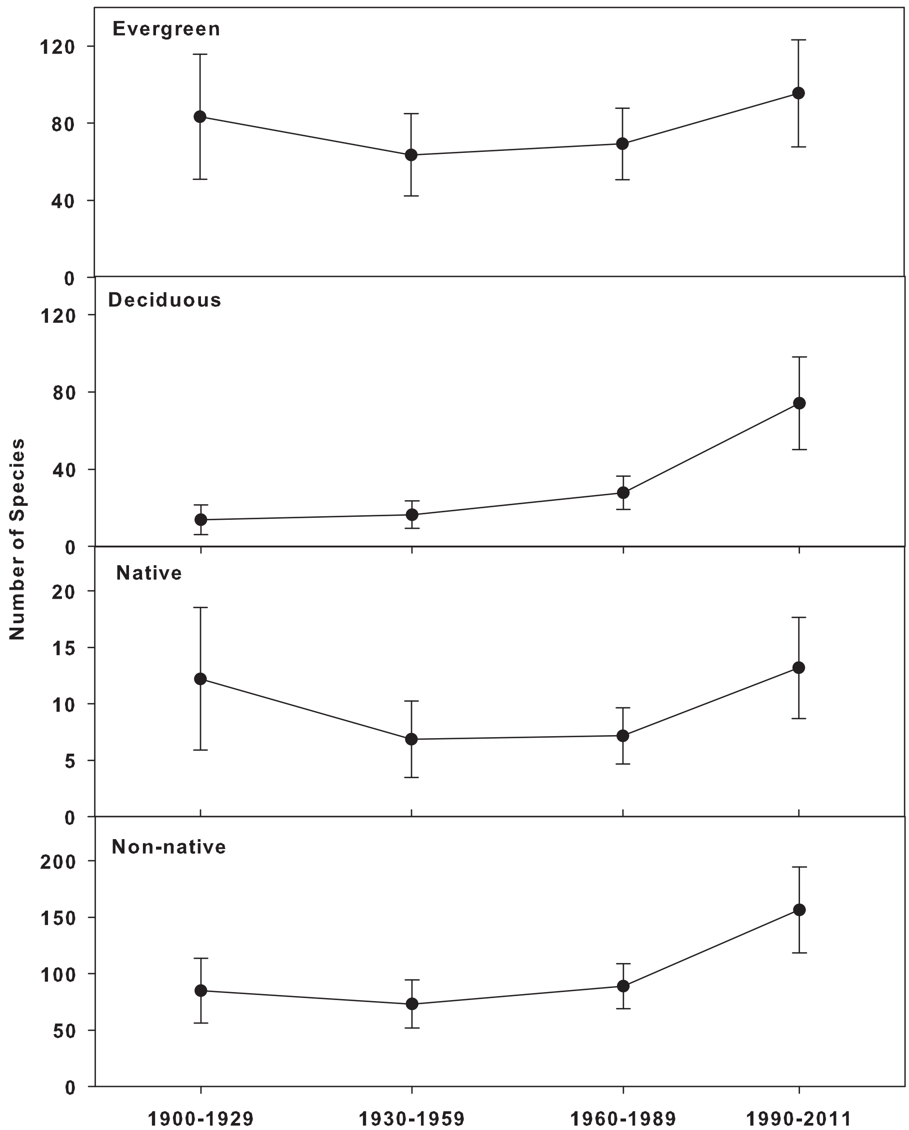

Fig. 3. Change in Evergreen, Deciduous, Native and Non-native Tree offerings over time

difference in the number of angiosperm species offered in time periods 1900–1929, 1930–1959, and 1960–1989. A significant linear ($p < 0.05$) and quadratic ($p < 0.05$) trend was observed with time (Fig. 4).

Palm trees are highly visible and arguably iconic in the Los Angeles landscape. Interestingly, the number of palm species offered in time period 1900–1929 was significantly greater than the number of species offered in time period 1930–1959. However, there was no statistically significant difference in the number of species offered in time periods 1930–1959, 1960–1989, and 1990–2011. An overall quadratic trend was observed with time ($p < 0.05$) (Fig. 4).

3.4. Popular trees species

Popular species were defined as species that have been offered consistently every decade in the 110-year study period (Table 3). The fifteen species offered each decade belonged to nine families and 13 different genera. Thirteen species were non-native and only two species were native to California (*Sequoia sempervirens* and *Sequoiadendron giganteum*) both of which grow poorly in Southern California and, despite being offered, are not often found in the urban fabric. Out of the 15, 13 were evergreen and two were deciduous; nine were angiosperm species and six were gymnosperms; two were palm species.

4. Discussion

4.1. Nursery offerings in Los Angeles County

Our research numbers rely on tree nursery *catalogs*, and indicate an increase in the tree species choices offered by nurseries in the region over time, even though the actual numbers of nurseries in the region have declined in number (Bradley J Fickes, Sales Manager, Norman's Nursery, March 16, 2012, personal communication). According to our interviews, increases in knowledge about disease susceptibility and the importance of having a diverse selection of street tree species, for example, (Walter Warriner, Community Forester Santa Monica, May 4, 2012, personal communication) were cited as among reasons for the increase in the number of species offered by nurseries. Another reason cited is that as individuals, land developers, and city planners hear about new species from breeders, conferences, or personal contacts, they request these new species from the nurseries in the region (Bradley

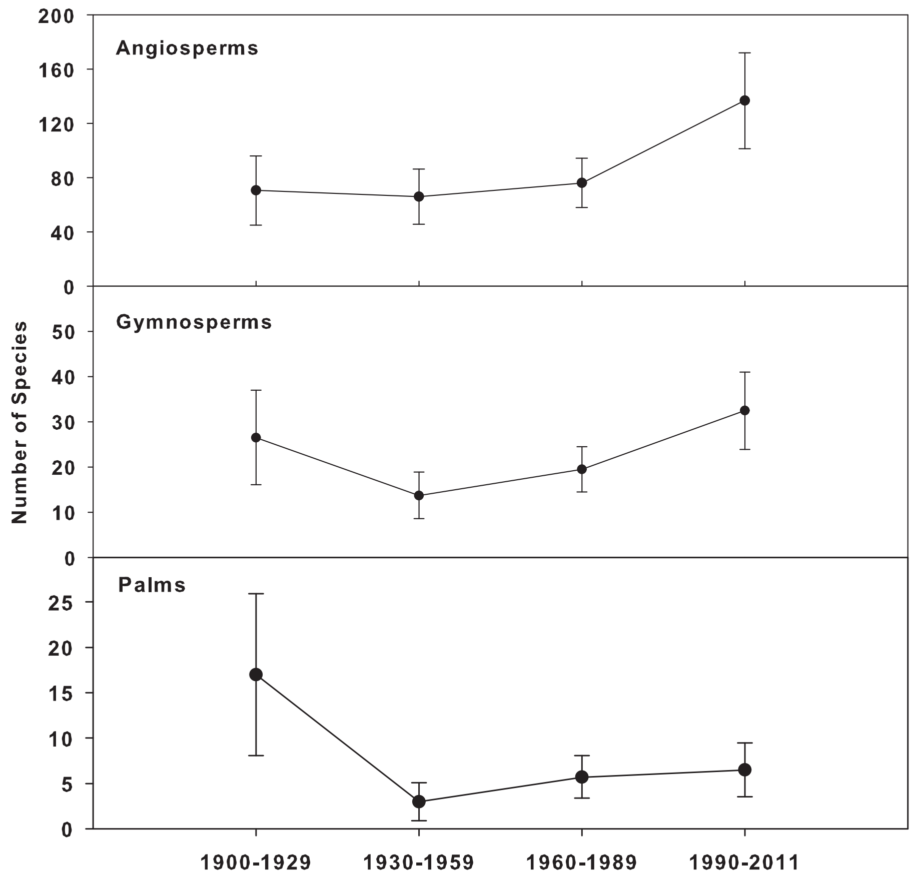

Fig. 4. Change in Angiosperms, Gymnosperms and Palm Tree Offerings over time.

J Fickes, Sales Manager, Norman's Nursery, March 16, 2012, personal communication).

4.2. Changes in diversity of tree species offerings

At regional to global scales there is strong evidence of declines in species diversity in non-urban ecosystems accompanied by increases in exotic species (Sax & Gaines, 2003; Muller & Bornstein, 2010). Research on urban biodiversity however, shows that there are increases in biodiversity in cities due to invasive species as well as human interventions in planting horticultural species (Marris, 2011). Unlike in non-urban habitats where Sax (2002) and Brown and Peet (2003) found that native and exotic diversity are often positively correlated, suggesting that where species richness has increased (Sax & Gaines, 2003), urban floristic diversity often comes at the expense of the native landscape. To create optimal conditions for construction, native vegetation is scrapped, fill is often brought in as well as top soil, contours and topography altered, irrigation may be added, soils are compacted, and high rates of fertilizers and chemicals are applied (Pincetl, 2012). This does not mean, however, that the urban plant palate is depauperate. As Kowarik (2011) points out, urban areas may be more species rich compared to their surrounding environments. Urban floristic diversity is driven by anthropogenic biophysical changes in the landscape and human choice in revegetation (Pincetl, 2012) as well as urban morphology (e.g. dense high-rise towers versus low-density suburbs) and climate. These are significantly different drivers of species diversity than in non-urban environments. Since Los Angeles is in a

Table 3
Fifteen species offered consistently from 1900 to 2011.

	Scientific name	Common name(s)	Geographic origin
1	*Bauhinia purpurea*	Purple Orchid Tree	S. China and S.E. Asia
2	*Cedrus atlantica*	Mt. Atlas Cedar	Atlas Mts. (No. Africa)
3	*Cedrus deodara*	Deodar	Himalayas
4	*Cupressus sempervirens*	Italian or Mediterranean Cypress	So. Europe, West Asia
5	*Jacaranda mimosaefolia*	Jacaranda	Brazil
6	*Lagerstroemia indica*	Crape Myrtle	Australia, India, S. China
7	*Magnolia grandiflora*	Southern Magnolia	Southern U.S.
8	*Olea europaea*	Olive	E. Mediterranean and S.W. Asia
9	*Phoenix canariensis*	Canary Island Date Palm	Canary Island
10	*Schinus molle*	Californian (Peruvian) Pepper	Peru
11	*Schinus terebinthifolius*	Brazilian Pepper	Brazil
12	*Sequoia sempervirens*	Coast Redwood	Northern and Central Coastal ranges of Calif.
13	*Sequoiadendron giganteum*	Giant Sequoia, Giant Redwood	Sierra Nevada (California)
14	*Thuja occidentalis*	Northern Whitecedar	NE North America
15	*Washingtonia robusta*	Mexican Fan Palm	Lower Cal. & Sonora, Mexico.

semi-arid environment, remnant or feral vegetation in non-cultivated spaces of the urban environment tends to be weedy and scrubby and trees rarely regenerate, except where there is water. In irrigated but poorly maintained areas, such as in freeway interchanges, one might find a mix of eucalyptus, *Schinus terebinthifolius*, *Ailanthus altissima*, and other opportunistic species. In non-irrigated areas, there are low-growing grasses and Mediterranean-region invasive plants. There are fewer non-built lots than in other cities in the U.S., for example Baltimore or Detroit. Los Angeles County is most densely populated and the most populous in the U.S (U.S. Census, 2012); and there is little open land outside of parks.

There has been a significant increase in tree diversity in Los Angeles from the 14 native species present in Los Angeles County before European contact. Our results show that there are now over 500 commercially available species of trees (as of 2011). Muller and Bornstein (2010) describe between 95 and 408 tree species currently being planted in California cities, with an average of 185 per community. This confirms our findings of high available diversity. That study also reported that the number of approved species for future public planting is only 29% of the species in the existing inventory. If the goal of tree planting in the city is biodiversity, this is troubling. However, it is likely that approved species must satisfy concerns about water use, tree size, maintenance and other issues pertaining to feasibility and management costs. These attributes are also important issues relevant to urban biodiversity as tree mortality in urban areas is high, and there are constrained municipal budgets for tree maintenance (Pincetl, 2010a).

The increase in nursery catalog offerings has accelerated in the past two decades. It is difficult to quantify trends in diversity of tree planting and we acknowledge there is not necessarily a causal link between diversity of offerings shown in tree nursery catalogs and what is found in the urban landscape. Still it is worth considering the extraordinary diversity of offerings and to further investigate how that may affect urban tree planting in different cities in the Los Angeles region, and between different land uses: parks, street trees and trees in private yards. Perhaps, as Muller and Bornstein (2010) caution, there may in fact be a decline in the public tree planting sphere, but an increase in private tree diversity. Other questions that emerge from this work include whether there is a similar trend in other cities, the link between biodiversity and urban forest function, and important measures of biodiversity other than taxonomic. For example, tree diversity in Nordic cities showed that 70% of all newly planted trees in street environments belonged to one clone of *Tilia* (Sjöman, Östberg, & Bühler, 2012). Genetic diversity of urban forests may be a critical factor in urban forest health and sustainability. Overall, little is still known about urban trees in different parts of the globe, including their biodiversity, health, maintenance regimes, and the reasons why people plant some species and not others.

4.3. Changes in tree classifications

Over the study period there were significant shifts in tree types, with an increase in deciduous tree species. Deciduous species shed their leaves in the cooler months and provide shade in the hotter summer months and thus are functionally different than evergreen species. Such changes in the availability of functional types may affect the structure of the urban forest of Los Angeles, as old and diseased trees will likely be replaced by the tree species now available. Such a change may also affect the ecosystem services provided. For example, while research is increasingly showing that trees do little to sequester carbon in cities relative to the amount of carbon generated in fossil fuel combustion, and there is little evidence to date that trees improve air quality, trees do mitigate outdoor heat fluxes through outdoor shading and evapotranspiration (Jenerette, Harlan, Stefanov, & Martin, 2011; Pataki et al., 2011). More city-level studies of trees and water use, their impacts on outdoor heat related to their size and canopy and the trade-offs with water use and maintenance, would help municipal arborists better choose trees if ecosystem benefits were a desired outcome.

Employing a chronological analysis to analyze the species currently and historically available to plant in a region offers a novel way to understand urban tree composition. Trends in the popularity of tree types over time (for example, shift from evergreen to deciduous) can be reflected in nursery offerings. In Los Angeles County, seventy new species have been offered within the last decade (2000 onwards). While it is likely that not all species of trees offered by the nursery industry are successfully planted, there are additional interesting questions to be asked about the increase in species availability. These include the role of horticultural research, the dissemination paths for new species and/or new hybrids, the drivers of choice and adoption, and the impacts of such trees on the region itself. Will the new trees change water demand? Will they affect allergies? Will they change maintenance costs for cities, or the public? Will they provide habitat for birds and insects? Pairing this information with other costs such as tree maintenance, as well as people's preferences and purchases of specific species, can help inform policy and decision makers of environmental benefits and costs of urban forests in a given region. According to the Sales Manager of a nursery we interviewed, while having low-maintenance trees is an important criterion, functionality and beauty (for example, flowering trees) are still more significant variables in selling trees (Mark Barrios, Sales Manager of West Covina Nurseries, April 13, 2012, personal communication).

4.4. Species offered consistently from 1900 to 2011

We found over a dozen trees that have been consistently offered over the century. These include coast redwoods (*Sequoia sempervirens*) and giant Sequoia (*Sequoiadendron gigantea*). These species are native to California but not to the Los Angeles region (they are found further north), and *Sequoia* trees found in Los Angeles tend to show signs of stress and are not widely grown (Litvak, McCarthy, & Pataki, 2011). Tree catalogs may not match nursery stock and availability, nor are they necessarily good predictors of tree survival rates. The species that were found to be sold throughout the 112 years include flowering trees, deciduous and evergreen trees, a palm, but no trees native to Southern California. Thus further research must be conducted to determine the reasons for new tree species introductions, their popularity, and whether tree nursery catalogs are truly good predictors of the biodiversity of trees in the urban forest. This would link the functional traits that are desired with the catalog information.

5. Conclusion

The goal of this research was to explore a previously uninvestigated factor that may shape urban tree biodiversity over time, namely the tree species available through nurseries. This method can be applied to other cities, as the results reported here are focused on Los Angeles County. There are many unknown factors affecting urban tree biodiversity and how it may change over time. The history and diversity of urban trees are important to understand as cities are increasingly interested in the use of ecosystem services to be more sustainable (Beatley, 2009; Pincetl, 2010b). Different climate zones and the fiscal capacity of cities across the world may mean different consequences of planting and managing urban trees such as increased water requirements, or tree maintenance burdens on neighborhoods. Trees, as living entities, require maintenance and horticultural knowledge to perform well, and often cities and residents do not have the training and knowledge to best maintain them. It is generally difficult to find good data on tree mortality in cities, especially if tree planting is a public campaign and politicians' reputations are at stake (Pincetl, 2010a). In addition, cultural values may play important roles in attitudes toward trees and tree species. Finally, novel species assemblages in anthropogenic settings raise interesting questions for ecosystem science, as the specific species composition of trees in Los Angeles resembles no other in the world, though like in other cities, trees are likely to be impacted by air pollution, watering and fertilizing, soil compaction and other urban phenomena. Coupled with the extraordinary diversity in this region of the world, how these forests function remains to be further explored.

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